

**What Is Claimed Is:**

1           1.       A method for performing remote network management over an  
2 Ethernet connection between a local node and a remote node, wherein the  
3 Ethernet connection uses  $x$ -bit/ $y$ -bit ( $x$ B/ $y$ B) encoding, the method comprising:  
4           accepting a local Ethernet bit stream containing  $x$ -bit words at the local  
5 node;  
6           forming a second bit stream which carries network control/management  
7 information;  
8           selectively encoding the  $x$ -bit words from the local Ethernet bit stream into  
9  $y$ -bit words according to the bits from the second bit stream, thereby forming a  
10 third bit stream comprising  $y$ -bit words, wherein the third bit stream carries both  
11 information from the Ethernet bit stream and information from the second bit  
12 stream; and  
13           transmitting the third bit stream on a physical medium from the local node  
14 to the remote node.

1           2.       The method of claim 1, wherein forming the second bit stream  
2 involves time-division multiplexing a control channel and a number of constant  
3 bit-rate communication channels; and  
4           wherein the method further comprises terminating the constant bit-rate  
5 communication channels with local line interface units (LIUs) located within the  
6 local node and with remote LIUs located within the remote node.

1           3.       The method of claim 2, wherein time-division multiplexing the  
2 number of constant bit-rate communication channels involves time-division  
3 multiplexing a number of T1, E1, or DS3 channels.

1           4.       The method of claim 2, further comprising storing control  
2 information in a local register located within the local node;  
3           whereby the local register can collect information from, and can issue  
4 commands to, the local LIUs through at least one serial peripheral interface (SPI);  
5           whereby information stored in the local register can be extracted and  
6 transmitted through the control channel to the remote node; and  
7           whereby information stored in the local register can be updated with  
8 information received through the control channel.

1           5.       The method of claim 4, further comprising storing control  
2 information in a remote register located within the remote node;  
3           whereby the remote register can collect information from, and can issue  
4 commands to, the remote LIUs through at least one SPI;  
5           whereby information stored in the remote register can be extracted and  
6 transmitted through the control channel to the local node; and  
7           whereby information stored in the remote register can be updated with  
8 information received through the control channel.

1           6.       The method of claim 4, further comprising controlling the remote  
2 LIUs with a local control processor which can access the local register through an  
3 SPI;  
4           wherein the local control processor writes commands to be communicated  
5 to the remote LIUs in the local register; and  
6           wherein the local control processor collects information which is received  
7 through the control channel and which is subsequently stored in the local register.

1           7.       The method of claim 4, further comprising controlling the remote  
2   LIUs by issuing control commands stored in an erasable programmable read-only  
3   memory (EPROM) located within the local node;  
4           wherein the control commands are first transferred to the local register  
5   prior to being transmitted to the remote node.

1           8.       The method of claim 1, wherein the Ethernet connection is a  
2   100Base Ethernet connection, and wherein forming the third bit stream involves  
3   encoding 4-bit words into 5-bit words according to the second bit stream.

1           9.       The method of claim 1, wherein the Ethernet connection is a  
2   100Base Ethernet connection, and wherein forming the third bit stream involves  
3   encoding 8-bit words into 10-bit words according to the second bit stream.

1           10.      The method of claim 1, wherein the Ethernet connection is a  
2   1000Base Ethernet connection, and wherein forming the third bit stream involves  
3   encoding 8-bit words into 10-bit words according to the second bit stream.

1           11.      The method of claim 1, further comprising detecting whether the  
2   remote node has xB/yB demultiplexing capability through which the remote node  
3   can extract the encoded second bit stream.

1           12.      The method of claim 1, wherein forming the second bit stream  
2   involves including data-error status, alarm conditions, loss-of-synchronization  
3   signals, or instructions to configure an LIU within the second bit stream.

1           13.     An apparatus that performs remote network management over an  
2     Ethernet connection between a local node and a remote node, wherein the  
3     Ethernet connection uses  $x$ -bit/ $y$ -bit ( $x$ B/ $y$ B) encoding, the apparatus comprising:  
4           a receiving mechanism configured to accept a local Ethernet bit stream  
5     containing  $x$ -bit words at the local node;  
6           a multiplexing mechanism configured to form a second bit stream which  
7     carries network control/management information;  
8           an encoder configured to selectively encode the  $x$ -bit words from the local  
9     Ethernet bit stream into  $y$ -bit words according to the bits from the second bit  
10    stream, thereby forming a third bit stream comprising  $y$ -bit words, wherein the  
11    third bit stream carries both information from the Ethernet bit stream and  
12    information from the second bit stream; and  
13           a transmitting mechanism configured to transmit the third bit stream on a  
14    physical medium from the local node to the remote node.

1           14.     The apparatus of claim 13, wherein while forming the second bit  
2     the encoder is configured to time-division multiplex a control channel and a  
3     number of constant bit-rate communication channels; and  
4           wherein the local node further includes local LIUs located for terminating  
5     the constant bit-rate communication channels at the local node, and wherein the  
6     remote node further includes with remote LIUs located for terminating the  
7     constant bit-rate communication channels at the remote node.

1           15.     The apparatus of claim 14, wherein while time-division  
2     multiplexing the number of constant bit-rate communication channels the encoder  
3     is configured to time-division multiplexing a number of T1, E1, or DS3 channels.

1           16.     The apparatus of claim 14, further comprising a local register  
2     located within the local node for storing control information;  
3           whereby the local register can collect information from, and can issue  
4     commands to, the local LIUs through at least one SPI;  
5           whereby information stored in the local register can be extracted and  
6     transmitted through the control channel to the remote node; and  
7           whereby information stored in the local register can be updated with  
8     information received through the control channel.

1           17.     The apparatus of claim 16, further comprising a remoted register  
2     located within the remote node for storing control information;  
3           whereby the remote register can collect information from, and can issue  
4     commands to, the remote LIUs through at least one SPI;  
5           whereby information stored in the remote register can be extracted and  
6     transmitted through the control channel to the local node; and  
7           whereby information stored in the remote register can be updated with  
8     information received through the control channel.

1           18.     The apparatus of claim 16, further comprising a local control  
2     processor, wherein the local control processor is configured to:  
3           access the local register though an SPI;  
4           control the remote LIUs;  
5           write commands to be communicated to the remote LIUs in the local  
6     register; and to  
7           collect information which is received through the control channel and  
8     which is subsequently stored in the local register.

1           19.     The apparatus of claim 16, further comprising an EPROM located  
2     within the local node which stores control commands that can be issued to control  
3     the remote node, wherein the control commands are first transferred to the local  
4     register prior to being transmitted to the remote node.

1           20.     The apparatus of claim 13, wherein the Ethernet connection is a  
2     100Base Ethernet connection, and wherein while forming the third bit stream the  
3     encoder is configured to encode 4-bit words into 5-bit words according to the  
4     second bit stream.

1           21.     The apparatus of claim 13, wherein the Ethernet connection is a  
2     100Base Ethernet connection, and wherein while forming the third bit stream the  
3     encoder is configured to encode 8-bit words into 10-bit words according to the  
4     second bit stream.

1           22.     The apparatus of claim 13, wherein the Ethernet connection is a  
2     1000Base Ethernet connection, and wherein while forming the third bit stream the  
3     encoder is configured to encode 8-bit words into 10-bit words according to the  
4     second bit stream.

1           23.     The apparatus of claim 13, further comprising an auto-sensing  
2     mechanism configured to detect whether the remote node has  $xB/yB$   
3     demultiplexing capability through which the remote node can extract the encoded  
4     second bit stream.

1           24.     The apparatus of claim 13, wherein the multiplexing mechanism is  
2 configured to include data-error status, alarm conditions, loss-of-synchronization  
3 signals, or instructions to configure an LIU within the second bit stream.

1           25.     A computer-readable storage medium storing instructions that  
2 when executed by a computer cause the computer to perform a method for remote  
3 network management over an Ethernet connection between a local node and a  
4 remote node, wherein the Ethernet connection uses  $x$ -bit/ $y$ -bit ( $x$ B/ $y$ B) encoding,  
5 the method comprising:  
6           accepting a local Ethernet bit stream containing  $x$ -bit words at the local  
7 node;  
8           forming a second bit stream which carries network control/management  
9 information;  
10          selectively encoding the  $x$ -bit words from the local Ethernet bit stream into  
11  $y$ -bit words according to the bits from the second bit stream, thereby forming a  
12 third bit stream comprising  $y$ -bit words, wherein the third bit stream carries both  
13 information from the Ethernet bit stream and information from the second bit  
14 stream; and  
15          transmitting the third bit stream on a physical medium from the local node  
16 to the remote node.

1           26.     The computer-readable storage medium of claim 25, wherein  
2 forming the second bit stream involves time-division multiplexing a control  
3 channel and a number of constant bit-rate communication channels; and  
4           wherein the method further comprises terminating the constant bit-rate  
5 communication channels with local LIUs located within the local node and with  
6 remote LIUs located within the remote node.

1           27.     The computer-readable storage medium of claim 26, wherein time-  
2     division multiplexing the number of constant bit-rate communication channels  
3     involves time-division multiplexing a number of T1, E1, or DS3 channels.

1           28.     The computer-readable storage medium of claim 26, where in the  
2     method further comprises storing control information in a local register located  
3     within the local node;

4                 whereby the local register can collect information from, and can issue  
5     commands to, the local LIUs through at least one SPI;

6                 whereby information stored in the local register can be extracted and  
7     transmitted through the control channel to the remote node; and

8                 whereby information stored in the local register can be updated with  
9     information received through the control channel.

1           29.     The computer-readable storage medium of claim 28, wherein the  
2     method further comprises storing control information in a remote register located  
3     within the remote node;

4                 whereby the remote register can collect information from, and can issue  
5     commands to, the remote LIUs through at least one SPI;

6                 whereby information stored in the remote register can be extracted and  
7     transmitted through the control channel to the local node; and

8                 whereby information stored in the remote register can be updated with  
9     information received through the control channel.

1           30.     The computer-readable storage medium of claim 28, wherein the  
2     method further comprises controlling the remote LIUs with a local control  
3     processor which can access the local register through an SPI;



4            wherein the local control processor writes commands to be communicated  
5    to the remote LIUs in the local register; and  
6            wherein the local control processor collects information which is received  
7    through the control channel and which is subsequently stored in the local register.

1            31.    The computer-readable storage medium of claim 28, wherein the  
2    method further comprises controlling the remote LIUs by issuing control  
3    commands stored in an erasable programmable read-only memory (EPROM)  
4    located within the local node;

5            wherein the control commands are first transferred to the local register  
6    prior to being transmitted to the remote node.

1            32.    The computer-readable storage medium of claim 25, wherein the  
2    Ethernet connection is a 100Base Ethernet connection, and wherein forming the  
3    third bit stream involves encoding 4-bit words into 5-bit words according to the  
4    second bit stream.

1            33.    The computer-readable storage medium of claim 25, wherein the  
2    Ethernet connection is a 100Base Ethernet connection, and wherein forming the  
3    third bit stream involves encoding 8-bit words into 10-bit words according to the  
4    second bit stream.

1            34.    The computer-readable storage medium of claim 25, wherein the  
2    Ethernet connection is a 1000Base Ethernet connection, and wherein forming the  
3    third bit stream involves encoding 8-bit words into 10-bit words according to the  
4    second bit stream.

1           35.     The computer-readable storage medium of claim 25, wherein the  
2     method further comprises detecting whether the remote node has  $xB/yB$   
3     demultiplexing capability through which the remote node can extract the encoded  
4     second bit stream.

1           36.     The computer-readable storage medium of claim 25, wherein  
2     forming the second bit stream involves including data-error status, alarm  
3     conditions, loss-of-synchronization signals, or instructions to configure an LIU  
4     within the second bit stream.